SITE DESIGN USING GREEN INFRASTRUCTURE

Vermont DEC
Stormwater Training
Waterbury, Vermont
August 17, 2011

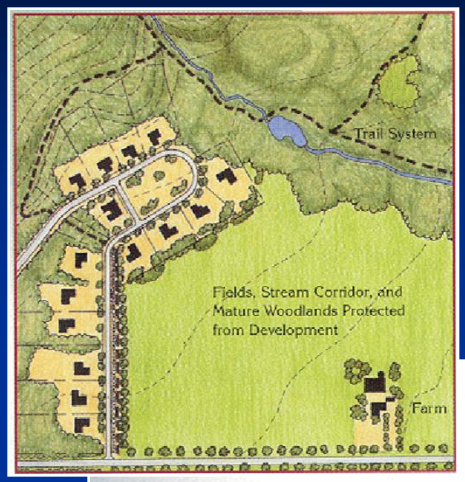
Green Infrastructure

A source control approach to development design that utilizes BSD, LID, and Conservation Design techniques.

- Avoid
- Reduce
- Minimize Impacts

Green Infrastructure Concepts :

- **Preserving Natural Features and Using Conservation Design**
- **Reducing Impervious Cover**
- **Using Natural Features and Source Control for Stormwater Management**



Green Infrastructure Concepts

- Preserving Natural Features and Using Conservation Design → Avoid the impacts
- Reducing Impervious Cover → Reduce the impacts
- Using Natural Features and Source Control for Stormwater Management → Manage the impacts

Green Infrastructure seeks to:

◄Use pervious areas for more effective stormwater treatment.

<u>AND</u>……

Keep and treat water on-site before discharging to local waterways

Vegetated Swale

Rain Garden

Green Infrastructure Practices are separated into Two Categories :

Planning Practices &

Runoff Reduction Practices

Planning Practices for Preservation of Natural Features

1. Preservation of Undisturbed Areas
2. Preservation of Buffers
3. Reduction of Clearing & Grubbing
4. Locating Sites in Less Sensitive Areas
5. Open Space Design
6. Soil Restoration

Planning Practices for Reduction of Impervious Cover

7. Roadway Reduction
8. Sidewalk Reduction
9. Driveway Reduction
10. Cul-de-sac Reduction
11. Building Footprint Reduction
12. Parking Reduction

Treatment Practices for WQv are further divided into two additional categories :

a. Runoff Reduction by Area and,

b. Runoff Reduction by Volume

Area Reduction Practices

1. Conservation of Natural Areas
2. Vegetated Buffers, Filter Strips for Impervious Disconnection and Riparian Reforestation
3. Tree Planting / Tree Box
4. Rooftop Disconnection
5. Stream Daylighting

Volume Reduction Practices

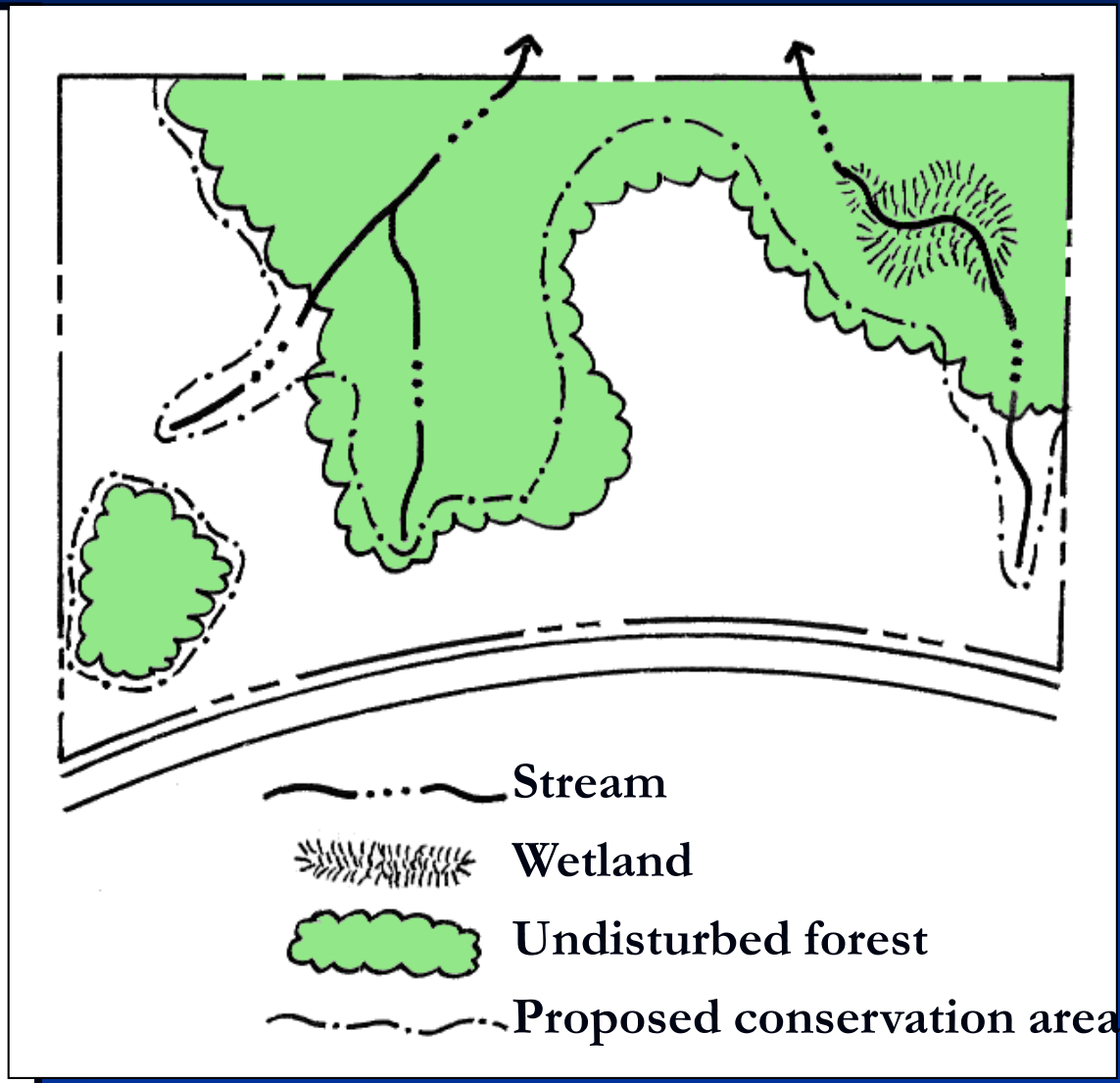
1. Rain Garden
2. Green Roof
3. Stormwater Planter
4. Stormwater Cistern/Tank
5. Permeable Paving
6. Vegetated Swale

Planning Practice #1 :
Preservation of Undisturbed Areas

- Delineate & Place in permanent conservation:
  - Undisturbed forest
  - Native vegetation
  - Stream corridors
  - Floodplains
  - Wetlands

Planning Practice #1 : Preserve Undisturbed Areas

- Protect during:
  - Design
  - Construction
  - Home occupancy
- Permanent conservation techniques:
  - Easement
  - Purchase

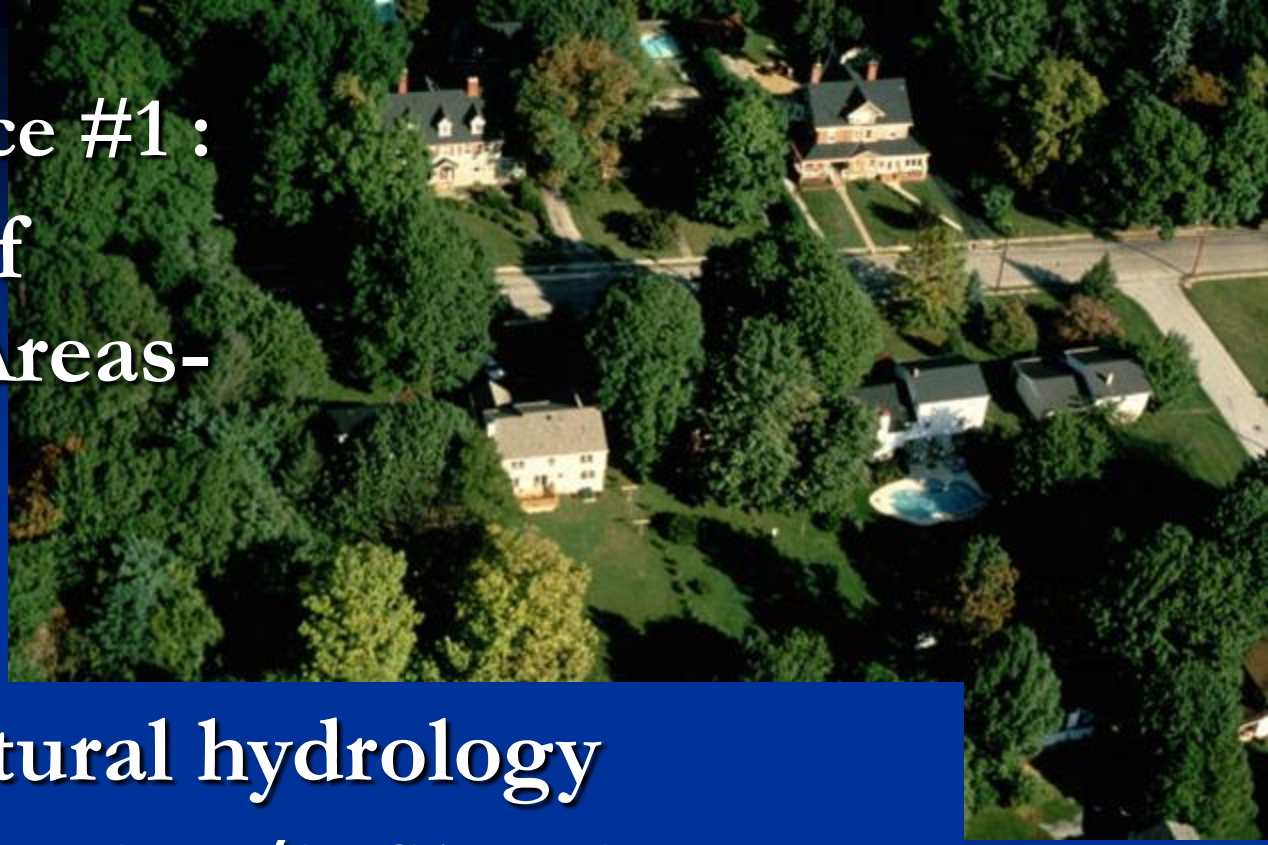


Planning Practice #1
Preservation of Undisturbed Areas

"Delineate and avoid disturbing wetlands, stream corridors"

"The plan must have resource protection at the core"

Planning Practice #1 : Preservation of Undisturbed Areas-



Benefits:

- Preserves natural hydrology
- Promotes filtration/infiltration
- Preserves natural character, habitat, aesthetic appeal
- Increases property values
- Reduces SMP storage size

Planning Practice #2 : Preservation of Buffers

US Forest Service

- Delineate stream, river and wetland buffers on plans.
- Protect during:
  - Design
  - Construction
  - Home occupancy
- ***Consult/amend local codes***

Planning Practice #2 : Preservation of Buffers

"Maintain vegetative buffer strips between disturbed and adjacent areas"

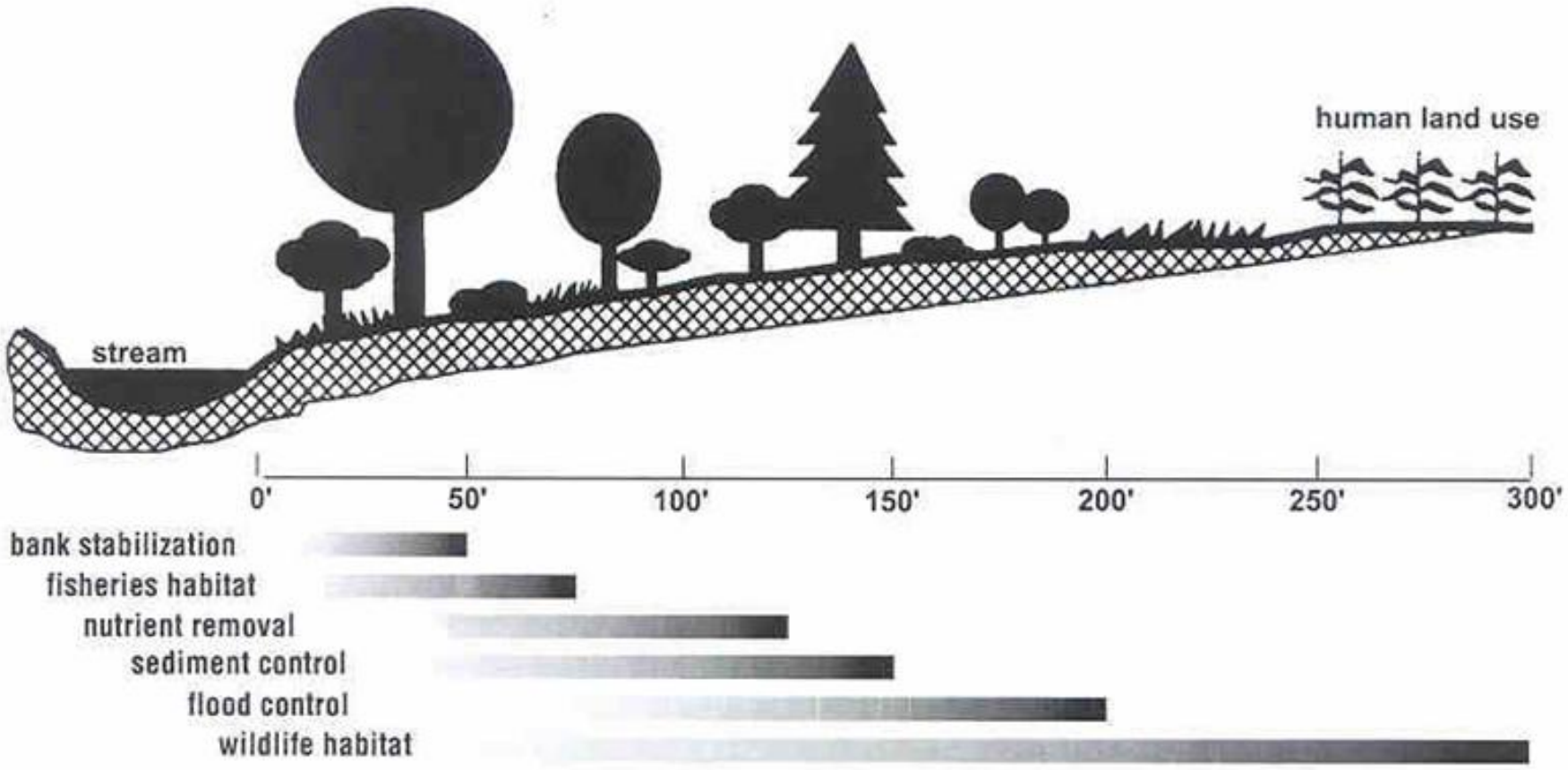
Planning Practice #2 :

Preservation of Buffers

Benefits:

- Natural stormwater treatment
- Promotes infiltration
- Preserves habitat
- Recreation area
- Right-of-way for flood events

Planning Practice #2 : Preservation of Buffers



Also: Westchester Co.: A Guide to Aquatic Buffers

Planning Practice #3 :

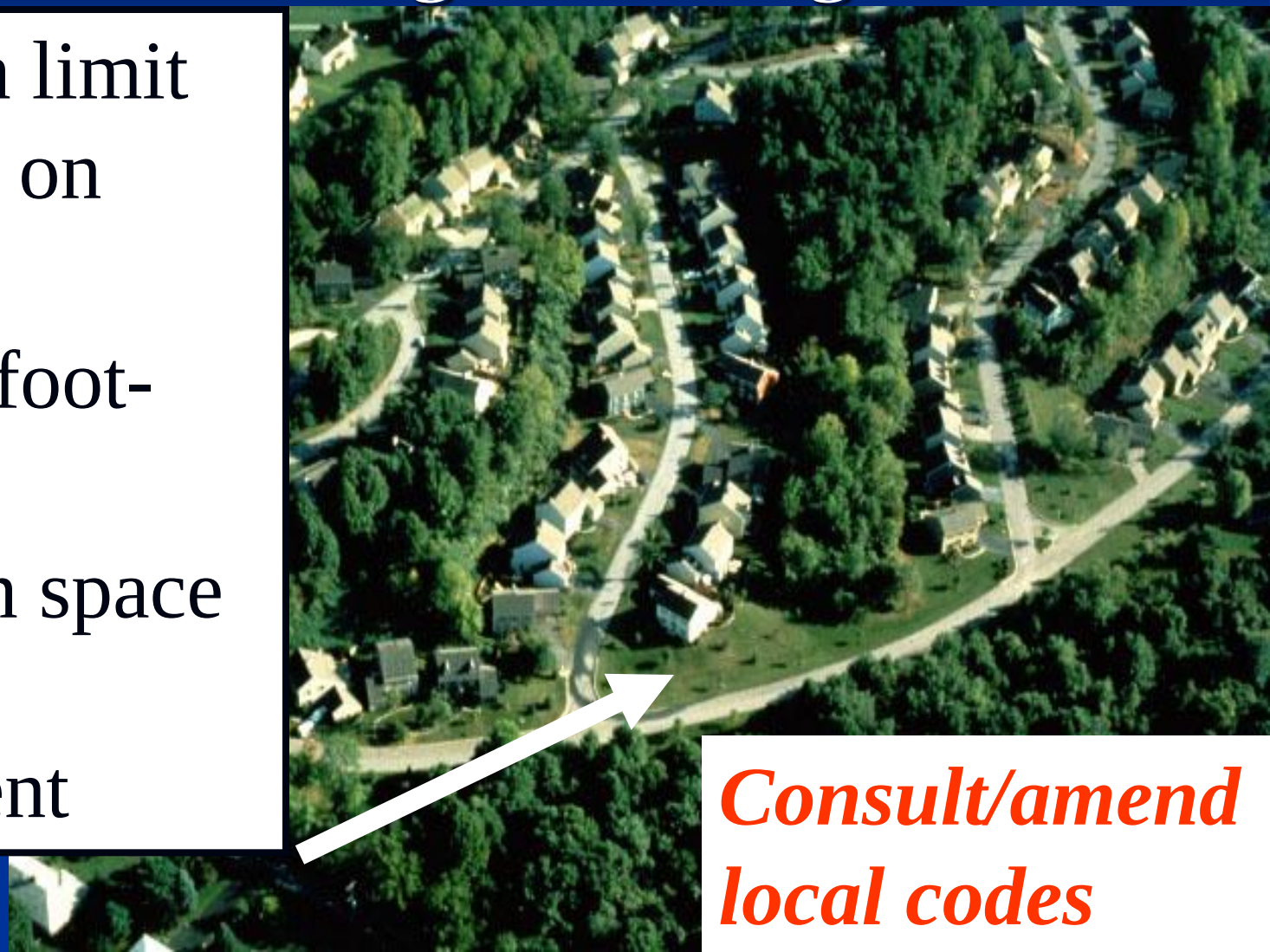
Reduction of Clearing & Grading

- Limit mass grading
- Limit to minimum needed for:
  - Buildings
  - Roads
  - Utilities
  - Wastewater
  - Stormwater

Planning Practice #3 :
Reduction of Clearing & Grading

Photo:
Randall Arendt

- Establish limit of clearing on plans
- Use site foot-printing
- Use open space or cluster development



Consult/amend local codes

Planning Practice #4 :

Locate Sites in Less Sensitive Areas

- Locate development to avoid:
  - Erodible soils
  - Floodplains
  - Steep slopes
  - Wetlands
  - Mature Forests
  - Critical habitat

Planning Practice #4 :

Locate Sites in Less Sensitive Areas

Benefits of preserving floodplains:

- Protects people & property values
- Storage for floods
- Preserves habitat

Planning Practice #4

Benefits of avoiding steep slopes:

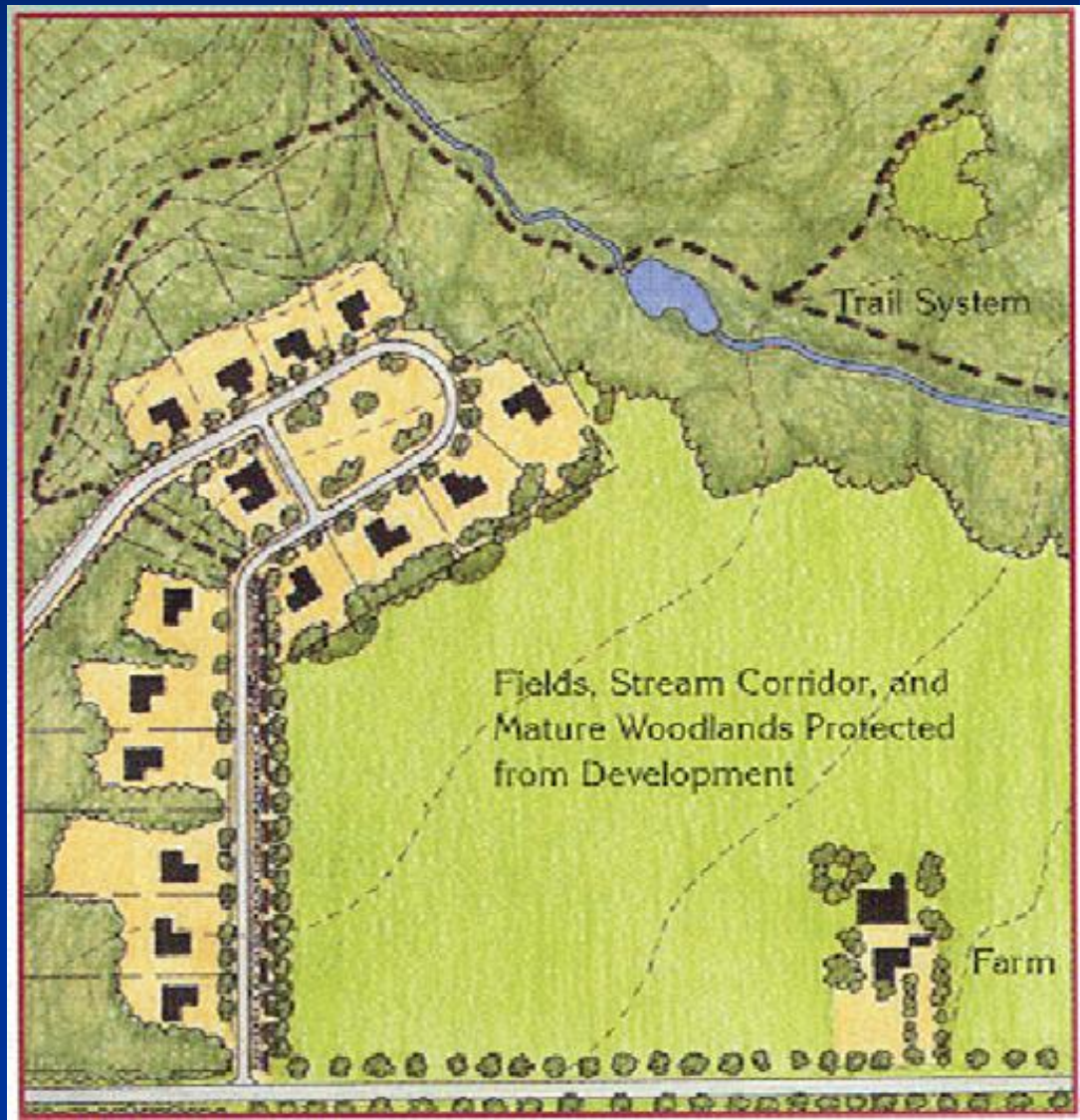
- Prevents soil erosion
- Reduces stormwater runoff
- Stabilizes hills
- Saves costs on cut and fill grading

Planning Practice #5 :
Open Space Design

Consult/amend local codes

- Use smaller lot sizes
- Design non-traditional lot layouts

Locate lots in least sensitive areas



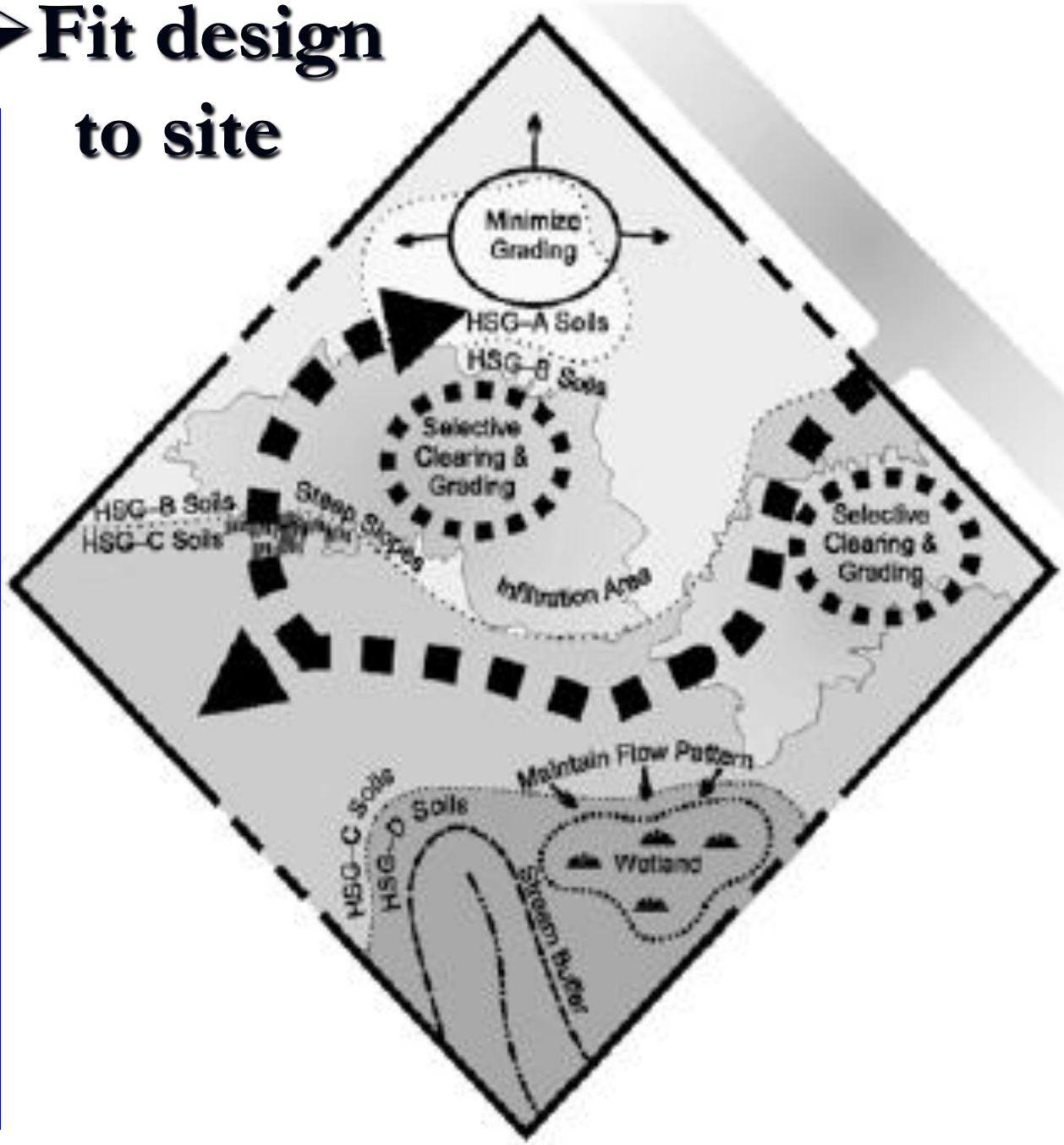
Soils

- KNOW & MAP YOUR SOILS
- Hydrologic soil groups A and B – Leave natural/open space – allows infiltration
- Hydrologic soil groups C and D (non-wetland) – Buildings, roads, driveways
- Hydrologic soil group D wetland soils - conserve
- Highly erodible or unstable soils – leave undisturbed and vegetated

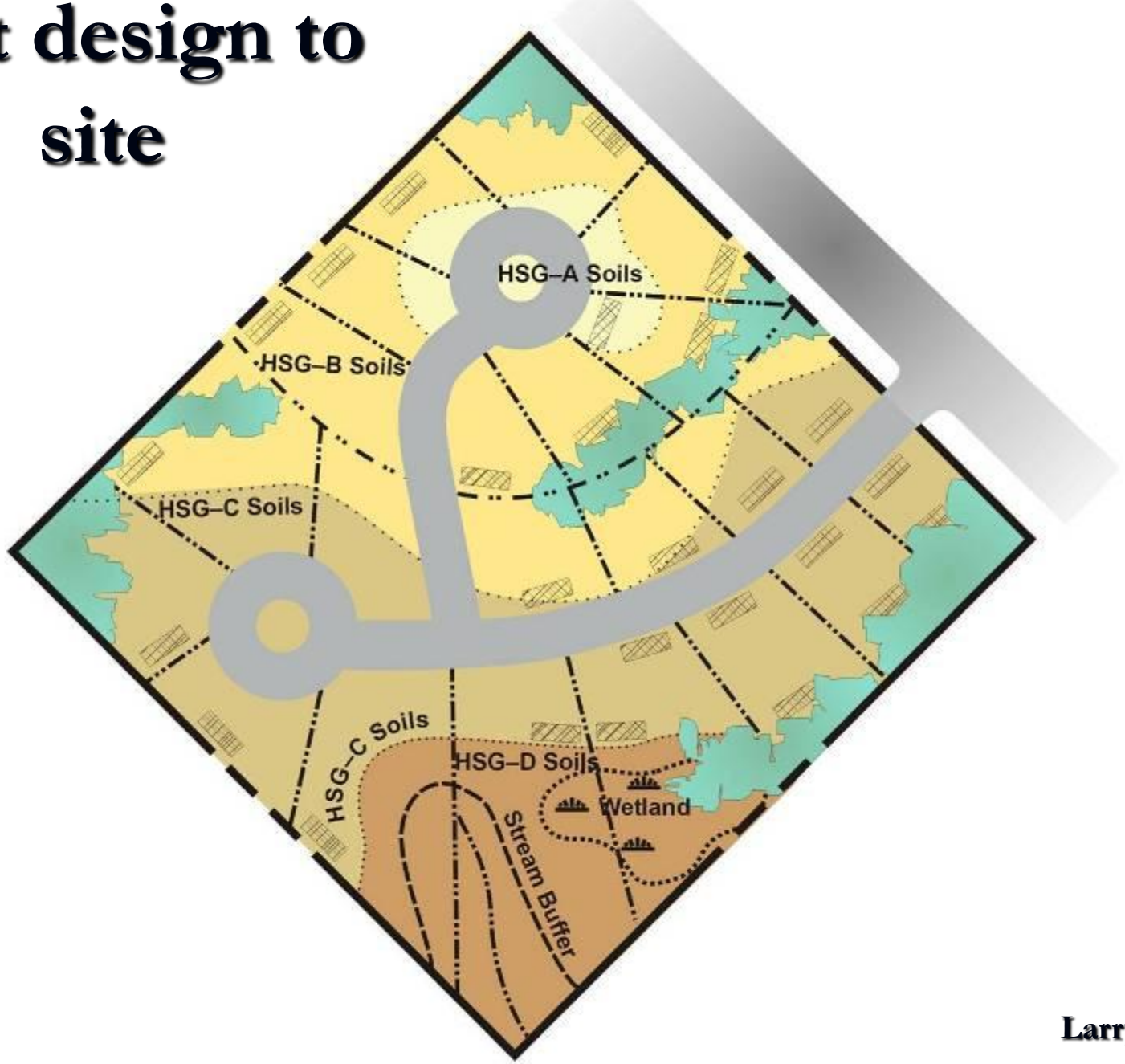
➢Fit design to site

Benefits:

- Preserves natural hydrology
- Reduces land disturbance
- Framework for site layout



➢Fit design to site



Larry Coffman

Low-impact Development Design

Planning Practice #5 : - Open Space Design

- Reduce impervious cover
- Reduce setbacks & frontages
- Use narrower road widths
- Provide more undisturbed open space
- Protect water resources

Connecticut subdivision – photo courtesy of NEMO program

Planning Practice #5 : Open Space Design

The Cost of Open Space Management

Open Space Management Strategy	Annual Maintenance Costs
Natural Open Space Only minimum maintenance, trash/debris cleanup	$75/acre
Lawns Regular mowing	$240 to $270/acre
Passive Recreation Trails, bike paths, etc.	$200/acre

Planning Practice #5 : Benefits of Open Space Design:

- Preserves natural hydrology
- Preserves conservation areas
- Saves costs - reduces grading
- Saves costs - reduces infrastructure

Photo: Randall Arendt

Planning Practice #6 : Soil Restoration

Planning Practice #6 : Soil Restoration

Planning Practice #6 : Soil Restoration

Often used with Redevelopment

Affects Post-Construction Hydrology

Planning Practices for Reduction of Impervious Cover

7. Roadway Reduction
8. Sidewalk Reduction
9. Driveway Reduction
10. Cul-de-sac Reduction
11. Building Footprint Reduction
12. Parking Reduction

Impervious Cover Reduction Practices

Benefits:

- Reduces impervious surfaces
- Reduces runoff and pollutants
- Reduces cost of building and maintaining roads
- Reduces homeowner maintenance
- Reduces paving costs
- Increases aesthetics & property value

Planning Practice #7 : Roadway Reduction

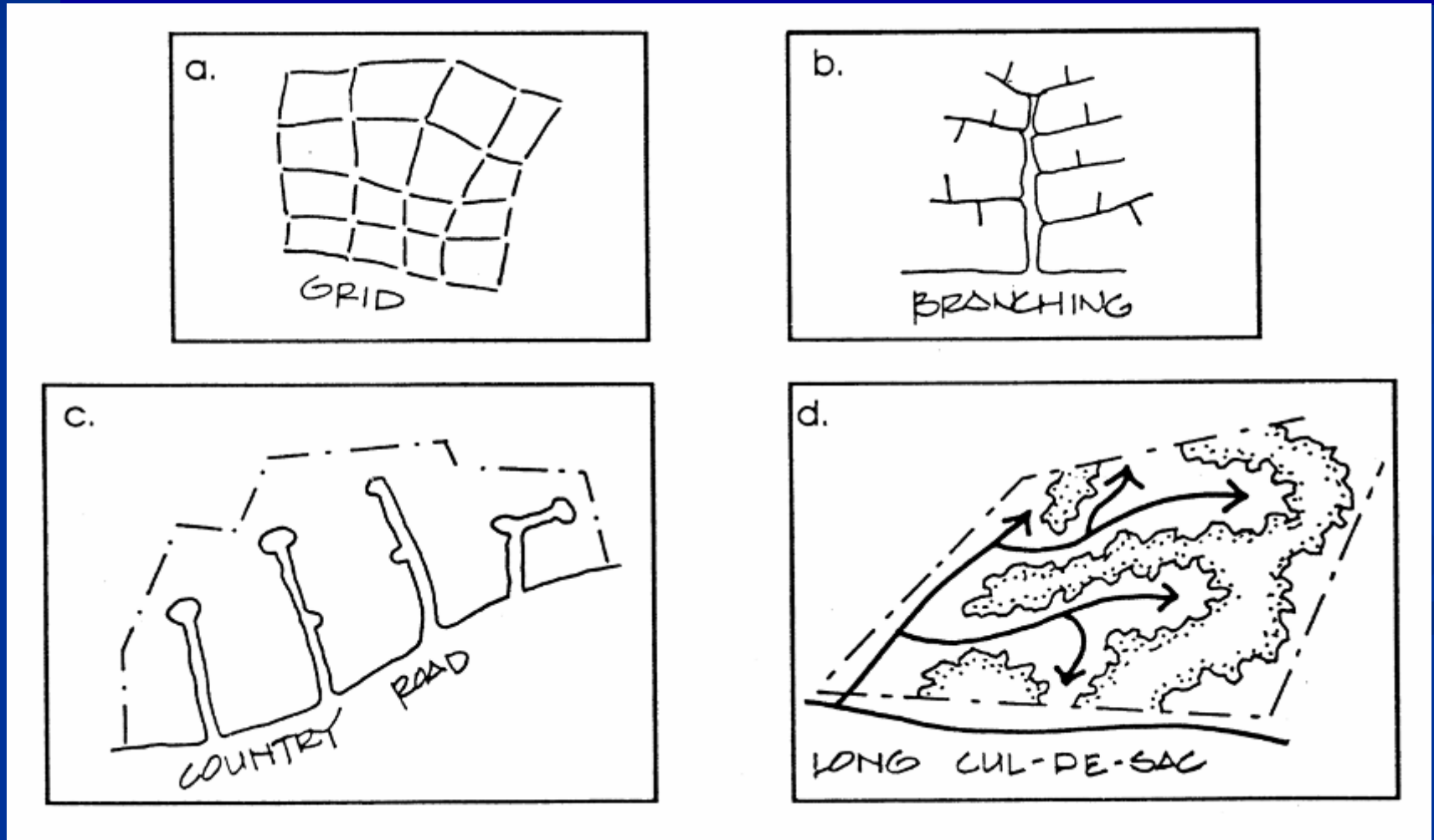
- Minimize roadway lengths
- Minimize roadway widths

Practice #7 : Roadway Reduction

- Design according to density and traffic demand

Planning Practice #7 : Roadway Reduction

- Use alternative road patterns to reduce overall road length



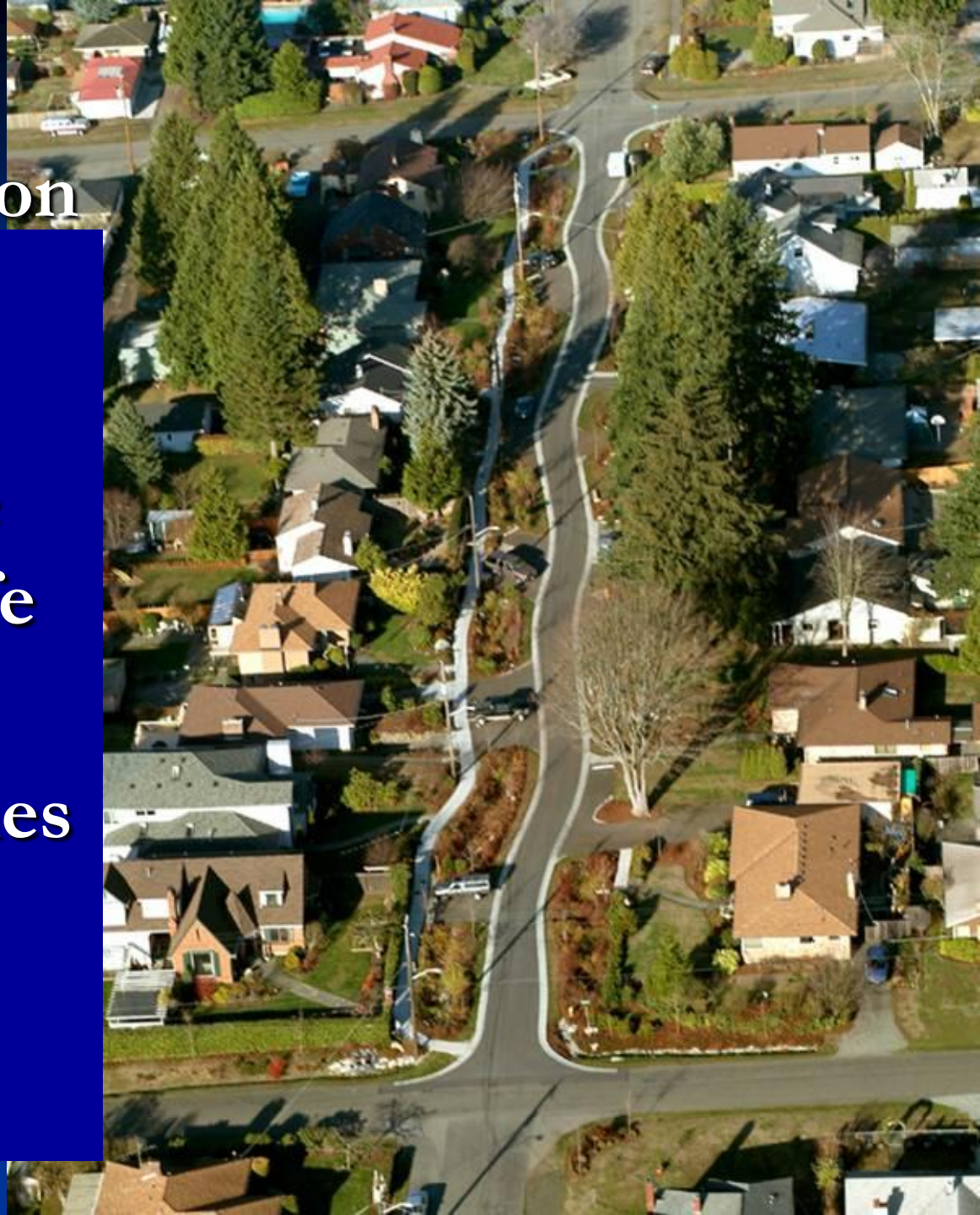
Planning Practice #8 : Sidewalk Reduction

- Use alternative designs
- Design on one side of street only
- Use alternative surfaces

Practice #8 : Sidewalk Reduction

Research:

- Accidents – sidewalks on one side nearly as safe as both sides
- Markets – Homes with/without sidewalks sell equally



Planning Practice #9 :
Driveway Reduction

- Reduce driveway lengths
- Reduce driveway widths

Planning Practice #9 : Driveway Reduction

How?

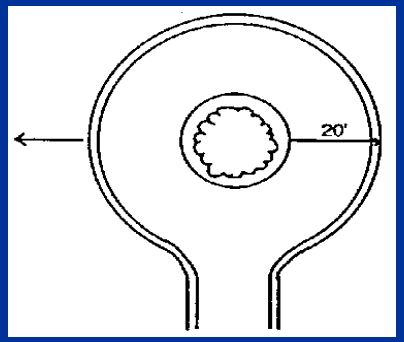
- Shared driveways
- Alternative materials
- Shorter setbacks = shorter driveways

Consult/amend local codes

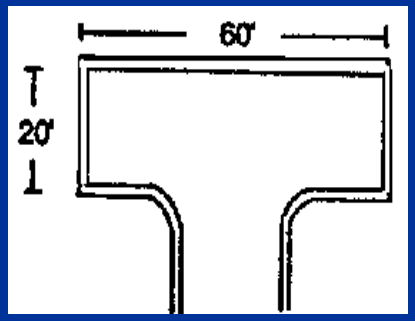
Planning Practice #10 :
Cul-de-Sac Reduction

- Minimize # cu-de-sacs
- Minimize radius
- Include landscaped island
- Use alternative designs . . .

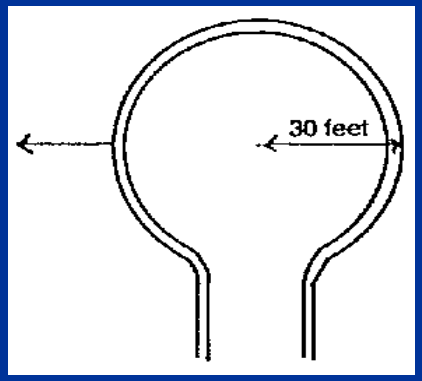
Planning Practice #10 :
Cul-de-Sac Reduction



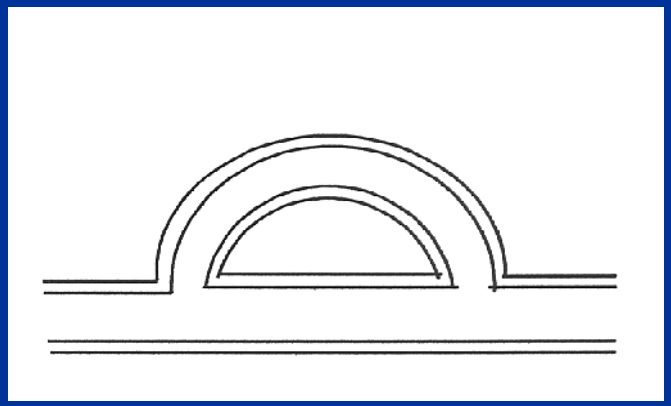
40 FT CUL-DE-SAC
W/ ISLAND



T-SHAPED
TURNAROUND



30 FT RADIUS
CUL-DE-SAC



LOOP ROAD

CENTER FOR WATERSHED PROTECTION

Planning Practice #10 :
Cul-de-Sac Reduction

Planning Practice #11 : Building Footprint Reduction

- Use alternate or taller buildings to reduce footprint
- Consolidate functions in one building

Planning Practice #11 : Building Footprint Reduction

- Reduce directly connected impervious area

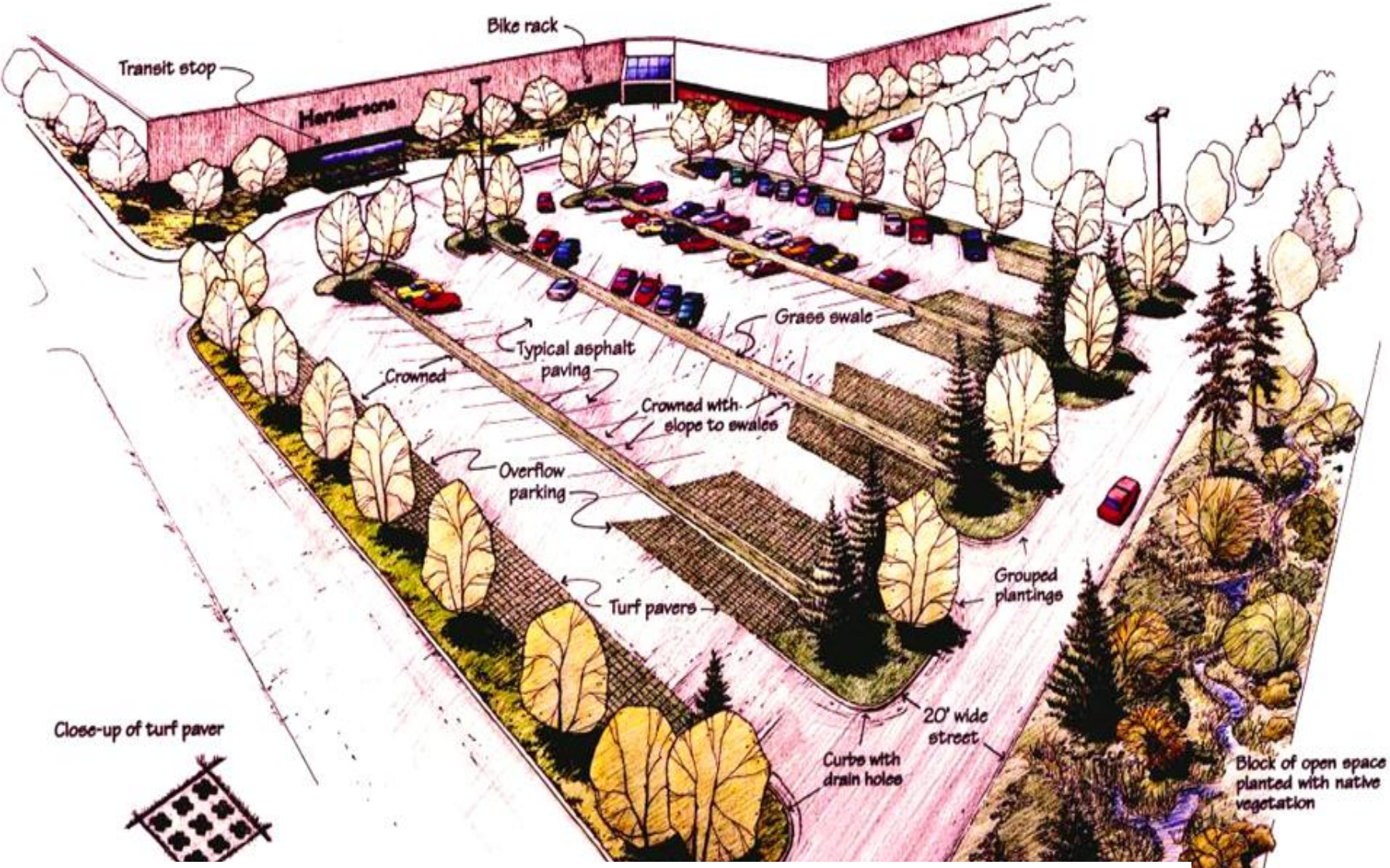
Planning Practice #12 :
Parking Reduction

- Compact car spaces
- Minimal stall dimensions
- Efficient parking lanes
- Parking decks
- Eliminate unneeded spaces

Planning Practice #12: Parking Reduction:

- Examine parking ratios

Land Use	Min. Parking Ratio	Typical Range	Actual Avg. Demand
Shopping center	5 spaces/ 1,000 sq. ft.	4.0-6.5	3.97/ 1000 sq. ft.
	Most municipalities require this		**Actual use based on studies**



Planning Practice #12:
➢ Parking Lot Reduction

Robert W. Droll
Landscape Architect, PE

Practice #12 : Reduce Parking Lot Imperviousness

- Use permeable pavers in overflow parking areas (RRv P #11)

Area Reduction Treatment Practices

1. Conservation of Natural Areas
2. Sheet Flow to Riparian Buffers or Filter Strips
3. Tree Planting / Tree Box
4. Disconnection of Rooftop Runoff
5. Stream Daylighting

Treatment Practice #1 : Conservation of Natural Areas

- Delineate & Place in permanent conservation:
  - Undisturbed forest
  - Native vegetation
  - Stream corridors
  - Floodplains
  - Wetlands

Treatment Practice #2 : Sheet Flow to Riparian Buffers or Filter Strips

➢Treat & control runoff with:

- Forested areas
- Stream buffers
- Vegetated filter strips

Treatment Practice #2 : Riparian Buffers/Filter Strips

Benefits:

- Filters & infiltrates runoff
- Saves costs – natural depressions are inexpensive stormwater storage
- Site design credit

Direct runoff as sheet flow to buffer/filter strip areas

Treatment Practice #3 : Tree Planting/Pit

- Plant trees to:
  - Reduce stormwater runoff
  - Absorb nutrients
  - Stabilize banks
  - Shade streams
  - Provide habitat

Treatment Practice #3 : Tree Planting/Pit

Benefits:

- Saves costs: natural landscaping
- Increases property values
- Absorbs heat
- Buffers wind & noise

Treatment Practice #4 : Disconnection of Rooftop Runoff

Direct flows to pervious areas.

Treatment Practice #5 : Stream Daylighting

Benefits:

- Increases aesthetics
- Sunlight kills pathogens
- Prevents flooding – increased storage
- Improves in-stream habitat
- Increases public use
- Increases property values

Volume Reduction Treatment Practices

6. Rain Gardens
7. Green Roofs
8. Stormwater Planters
9. Rain Barrels and Cisterns
10. Porous Pavement
11. Vegetated Swale

Volume Reduction Treatment Practices

OLD FRIENDS

1. Bioretention
2. Infiltration
3. Dry Swale

Treatment Practice #6 : Rain Gardens

- Treat runoff with:

  - Rain garden (simpler version of bioretention)
  - Use for Rooftop and overland flows.
  - Use in required landscaping

Treatment Practice #6 : Rain Gardens

Maximum drainage area 1,000 Sq.Ft.

Treatment Practice #6 : Rain Gardens

- 3-6” ponding layer
- 12-18” amended soil layer
- 3-6” gravel drainage layer

Treatment Practice #6 : Rain Gardens

Benefits:

- Better infiltration from small drainage areas
- Saves costs – landscaping + stormwater treatment
- Improves aesthetics
- Less thermal impact

Treatment Practice #7 : Green Roofs

Extensive Green Roof

Intensive Green Roof

Hyper-Extensive?

Treatment Practice #7 : Green Roofs

- Direct runoff from rooftops to:
  - Pervious areas
  - Rain barrels
  - Cisterns
  - Stormwater planters
  - Green roof

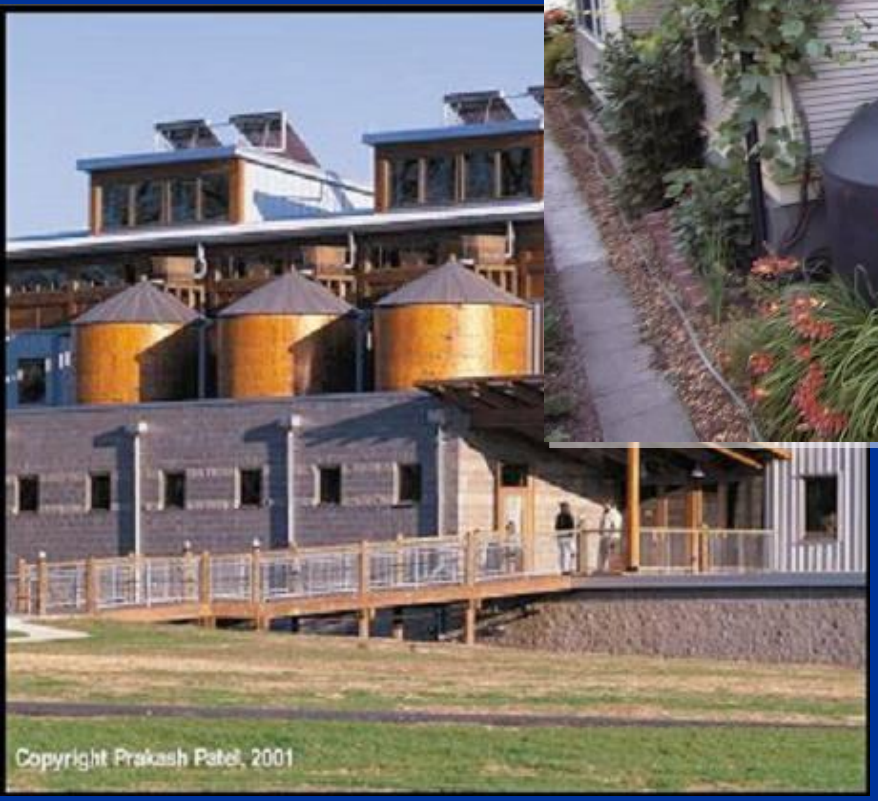
Treatment Practice #8 : Stormwater Planters

Treatment Practice #8 : Stormwater Planters

Benefits:

- Increases flow time
- Reduces peak flows
- Filters runoff
- Site design credit

Treatment Practice #9: Rain Barrels/Cisterns

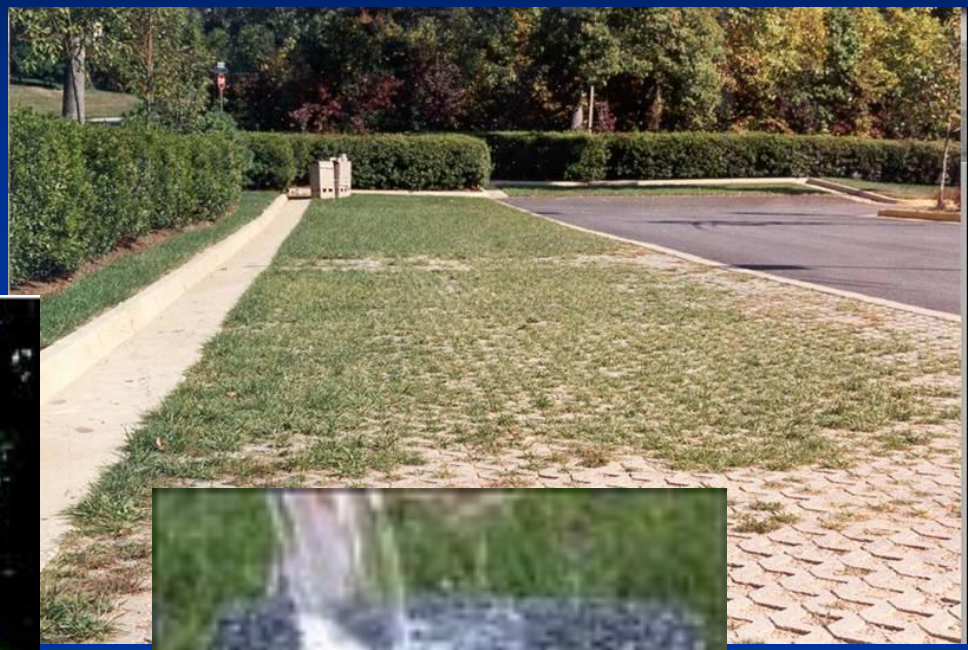


Treatment Practice #9: Rain Barrels/Cisterns

Direct Rooftop Runoff to Pervious Areas

- Rain Barrel: 20-100 gallons
- Cistern: thousands of gallons

Treatment Practice #10 : Porous Pavement



Treatment Practice #10- Porous Pavement

Porous Pavement

Treatment Practice #10 : Porous Pavement

Treatment Practice #10 : Porous Pavement

- Use permeable pavement/pavers where site conditions are appropriate:
  - Pedestrian areas
  - Overflow parking
  - Residential driveways

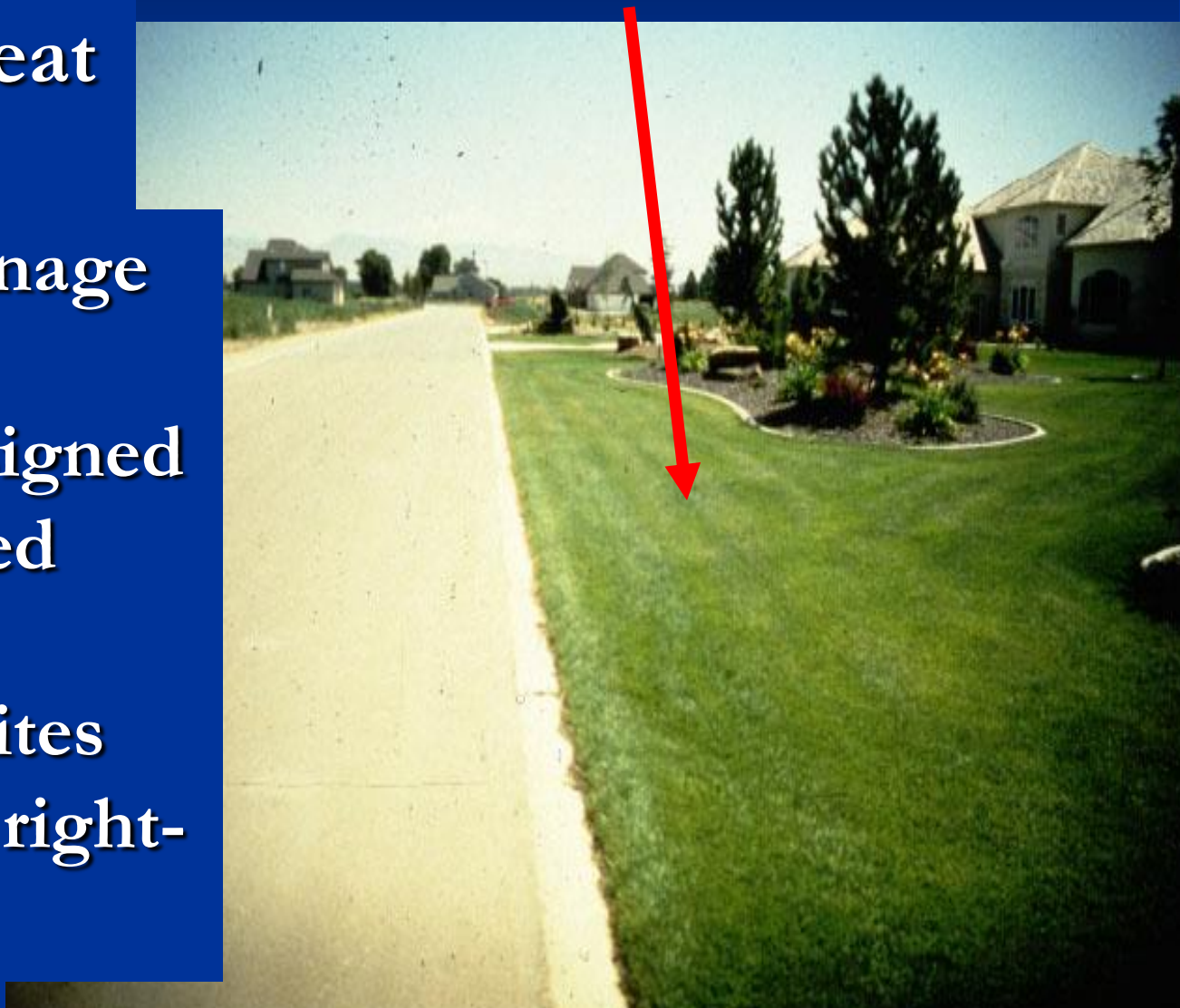
Treatment Practice #10: Porous Pavement

Permeable pavers in landscaping:

- Flat areas ideal
- Well-drained soils

Treatment Practice #11 : Vegetated Swale

- Convey & treat runoff with:
  - Natural drainage paths
  - Properly designed & constructed channels
- On certain sites use in street right-of-way

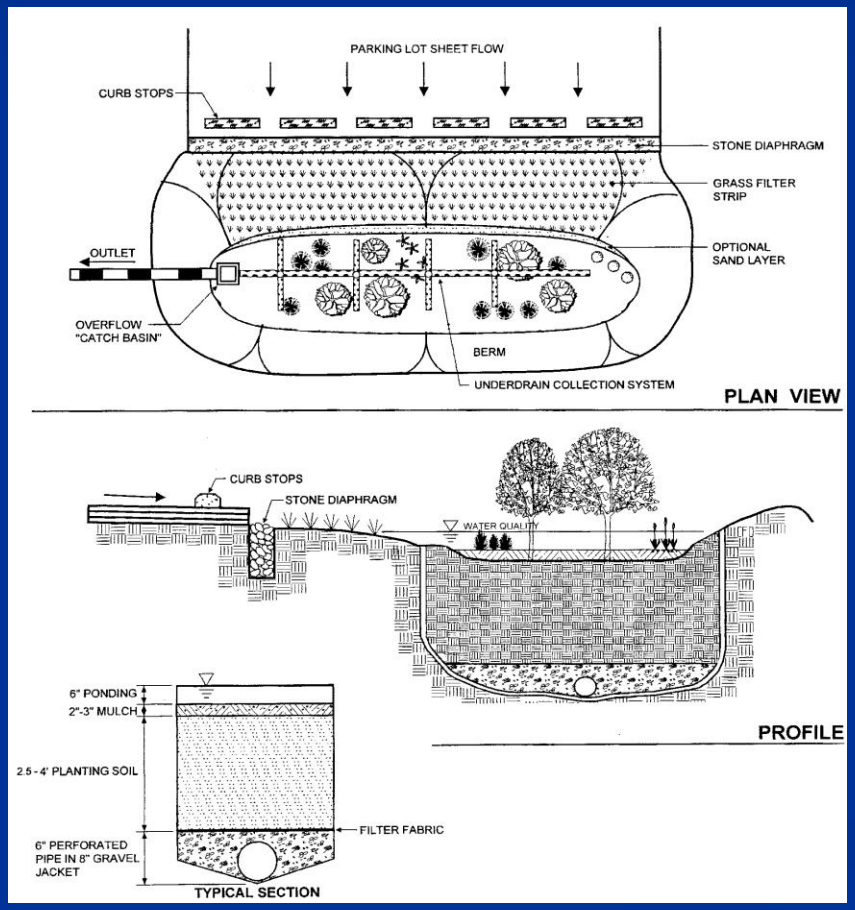


Treatment Practice #11 : Vegetated Swale

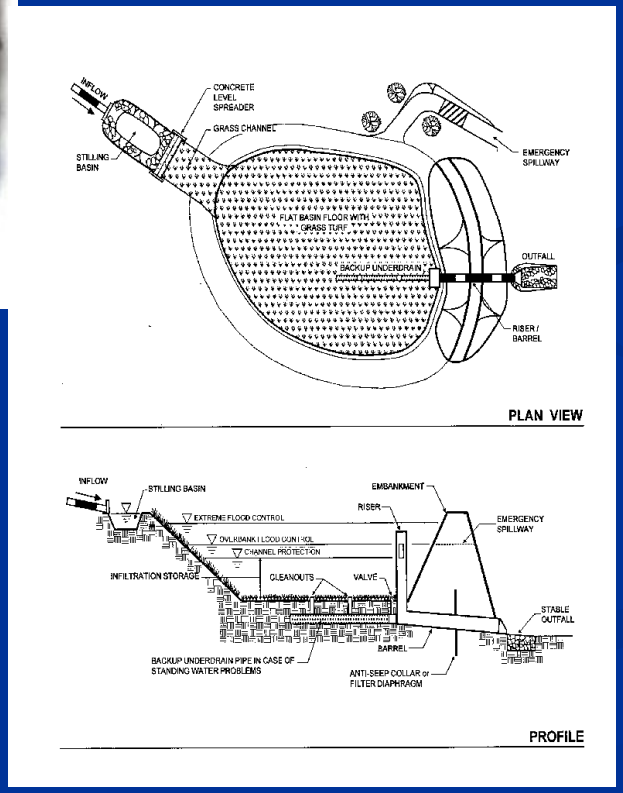
Benefits:

- Saves costs on road & storm sewer construction
- Provides runoff storage & treatment
- Increases travel time & lowers peak discharge

Old Friends
BIORENTENTION

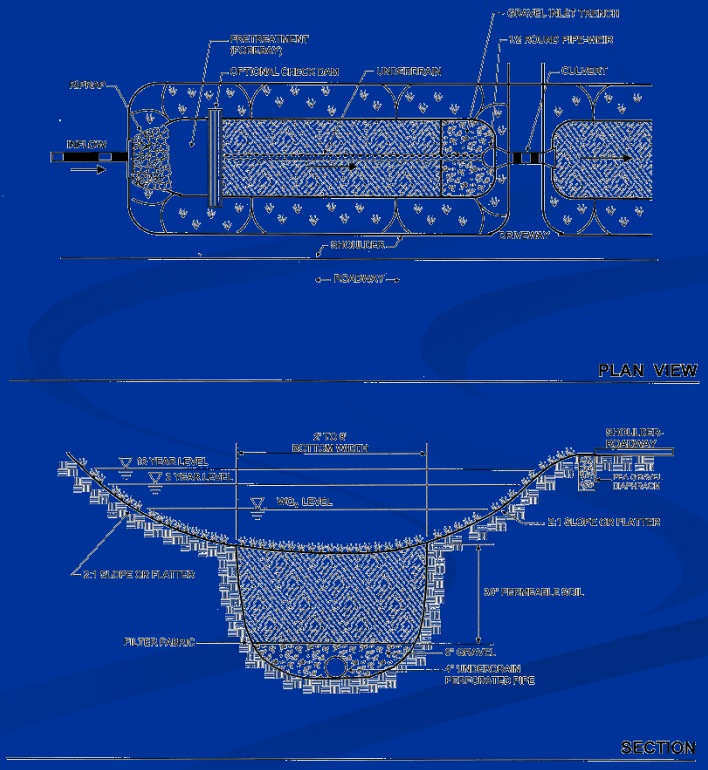


Old Friends
INFILTRATION



- Dry Well
- Infiltration Trench
- Infiltration Basin

Old Friends
DRY SWALE

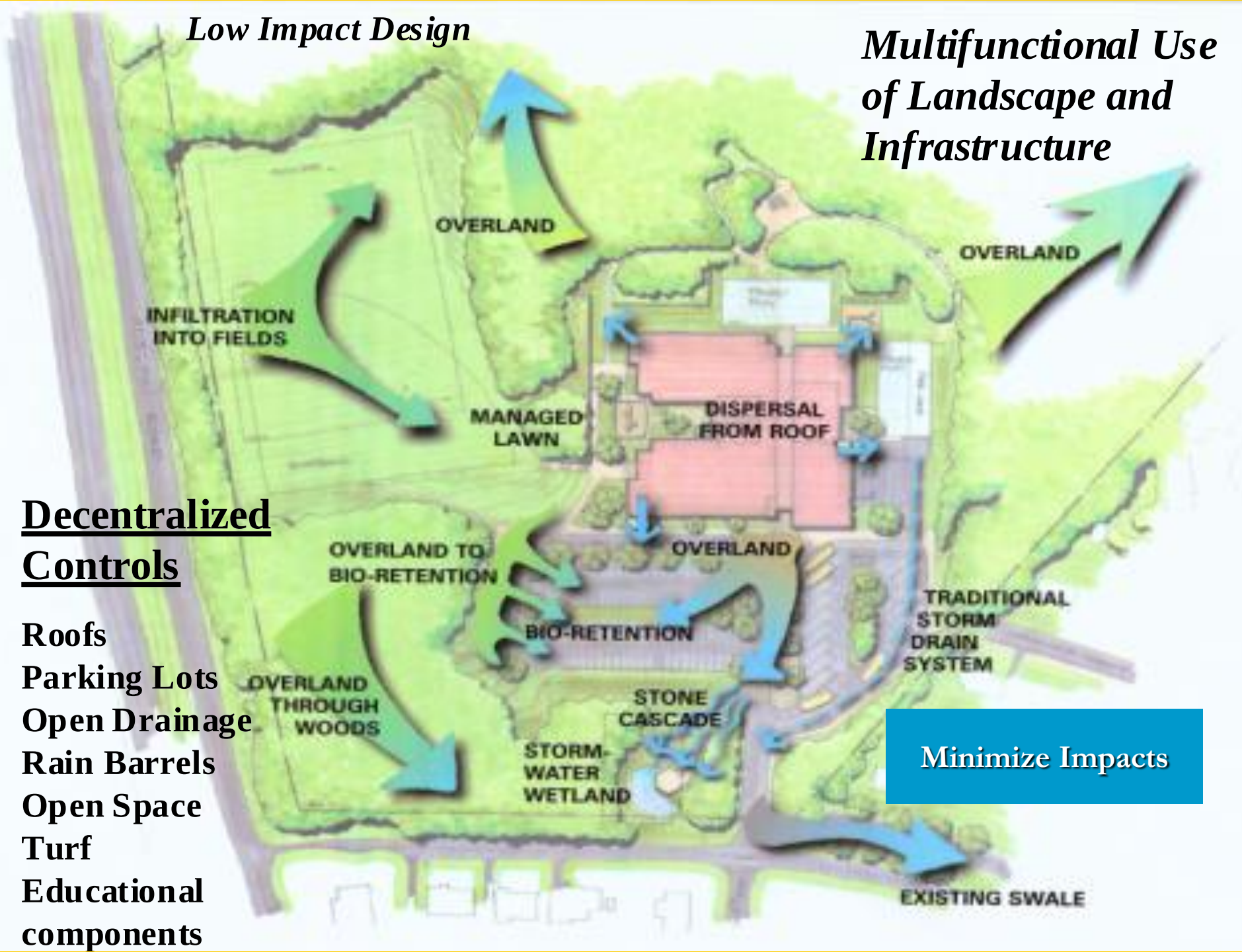


Using Green Site Planning &Design will improve our development projects and communities.

- Preserve undisturbed areas
- Reduce impervious cover
- Use pervious areas for stormwater treatment
- Achieve a marketable, cost-effective product

Low Impact Design

Multifunctional Use of Landscape and Infrastructure



Decentralized Controls

Roofs
Parking Lots
Open Drainage
Rain Barrels
Open Space
Turf
Educational components

Minimize Impacts